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The Production and Circulation of Manuscripts and Printed Books in China Compared to Europe, ca. 581–1840^{*}

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Abstract

Literature dealing with the history of Chinese printed books and printing is voluminous. Yet studies of how knowledge in general and utilitarian forms of knowledge in particular were generated, accumulated and circulated by printed books and their relationship with the long-term socio-economic transformation of China are rare. This paper aims to open up the subject by examining long-term trends in the production of manuscripts and books and focussing on connections between the generation and dissemination of useful knowledge in China and the production and circulation of printed books over the centuries and dynasties from circa 581 to 1840 compared to Europe. It connects trends in this indicator for knowledge formation and diffusion to economic growth, urbanisation, changes in higher forms of education, the rise of literacy, the development of printing technologies, and changes in perceptions of the natural world. It concludes that human capital formation in China probably proceeded at a slower rate, which is relevant for narratives of the 'divergence' between China and Europe.

I. Ways of Communication and Paths to Knowledge Formation in Oral and Literate Cultures

The emergence of writing led to different ways of communication and paths to knowledge formation.¹ In oral cultures, knowledge comes from immediate experience and speech, whereas in literature cultures, knowledge is codified. To acquire such codified knowledge requires learning 'the techniques of the written words' and how to order these words differently 'for different ends'.² Writing has also led to a differentiation within literate cultures, i.e., 'a differentiation between the "high" culture of the consumers of books and the "low" culture of those confined to the oral register'.³ Thus the paths to knowledge formation have been divided into a 'practical' mode through oral discourses and apprenticeships and a 'text-learning' mode which relied on books.⁴ 'The

1 Goody 1978, 1986.

2 Goody (1978: 152-153, 159).

3 Goody (1978: 162).

4 Goody (1978: 165). General histories of books and printing in pre-modern Europe include Febvre and Martin 1984; McLuhan 1962; Eisenstein 1979 and 1983; Johns 1998; Burke 2000; Raven 2007; Sher 2006; Long 2001; Eamon 1994. For the studies of connexions between knowledge formation and the history of books and printing, vide: Eamon 1994; Jones 1998; Burke 2000. For general histories of books and printing in pre-modern China, see Brokaw and Chow 2005; Carter 1955; Chia 2002; Chia and De Weerd 2010; Chow 2004; Greenbaum 2007; Han and Bussotti 2008; Zhang Xiumin 1989, 2009; Qian [Tsien] 1975, 1985; McDermott 2006; Twitchett 1983; Wu 1943; Qi 2007. For printing and popular culture, see Rawski 1979; Johnson et al 1985; on print and politics, see Judge 1996; on print and commercialisation, see Chow 2004; Chia 2003; Brokaw 1996; on print and the civil service examinations, see Chow 1996; on women and printing and reading, see e.g., Ko 1994.

modes of acquiring knowledge affect the nature of that knowledge and the way in which knowledge is organised'.⁵ As Goody argues: books 'served as stores of knowledge, to be copied exactly (physically so in the days before printing), as in the splendid calligraphy of the Qu'ran or the exquisite workshop of the medieval Books of the Hours. Later on they are copied mentally as text-books. The whole process of literate education becomes a matter of absorbing abstracted knowledge through mediators, either directly from books or indirectly from teachers...'⁶

II. Long Run Trends in the Production of Manuscripts and Books in China and Europe

1. The Evolution in Printing Technologies

Although scribal manuscripts still dominated and continued to exist in China until at least the nineteenth century,⁷ China has the longest history of printing in the world.⁸ Woodblock printing emerged in China in the sixth and seventh centuries.⁹ For centuries, its scope and use was limited to governmental and religious institutions.¹⁰ Real changes took place in the eleventh and twelfth centuries when new printing technologies including movable type (initially used in the printing of official contracts) and multi-colour type (initially used in the printing of New Year Pictures) emerged and facilitated the substantial growth in book production and an expansion of commercial printing.¹¹ More dramatic transformations occurred in 16th and 17th century China which witnessed rising literacy rates, falling book prices, and the increased demand for books either from those preparing for civil service examinations or those reading for entertainment including a wider readership of merchants, connoisseurs, artisans, farmers and women.¹² By this period the histories of books, printing and reading can no longer be separated.¹³

⁵ Goody (1978: 159).

⁶ Goody (1978: 158).

⁷ McDermott (2005: 90). This paper mainly deals with printed books.

⁸ An exhibition 'The Printed Image in China: From the 8th to the 21st Century' was held at the British Museum, 6 May-5 September 2010. A copy of the Chinese version of the *Diamond Sūtra* dated to 868 AD is the world's earliest survival of a dated printed book.

⁹ Pan (2008: 21). For the Chinese history of printing, see Zhang Xiumin (2009: 138-164).

¹⁰ Chia and De Weerd 2010: 13.

¹¹ Pan (2008: 21); Chia (2003: 286). More than thirty printing centres existed in the Northern Song and more than two hundred in the Southern Song (Zhang 1989: 59). From c. 1600 techniques for printing in colour reached a high level of sophistication (information gathered from the exhibition 'The Printed Image in China: From the 8th to the 21st Century' at the British Museum, 6 May-5 September 2010).

¹² By the middle of the 16th century, the cost of printing books had dropped to one-tenth of that two or three centuries earlier, see Brook (1988: 177-196, 181).

¹³ Chow (2010: 6). For studies of the Chinese histories of printing and reading, see Bussotti 2008. For the same arguments in the European context, see Burke (2008: 365).

Information on the technology of block printing is scarce and only available in sporadic remarks given by a few foreign observers (e.g., Matteo Ricci in c. 1600) or oral testimony by a few surviving craftsmen before this technology disappeared in the early 20th century.¹⁴ Some of the methods of movable type printing were recorded including wooden, earthenware, and bronze and other metal types.¹⁵ Wooden type became swollen and muddy after printing about two hundred copies'.¹⁶ Earthenware type was invented under the Northern Song ca. 1041-1048. It was more durable and could hold watery ink well.¹⁷ Movable bronze-type appeared in the eleventh and twelfth centuries and was initially used in the printing of money paper. It was hard and durable but did not hold ink well.¹⁸ Moreover, its production process was complex and more expensive for large-scale printing of books. It was later replaced by lead because of the scarcity of bronze.¹⁹

The nature of Chinese written language limited the practicability and potential use of movable-type printing in China. Since the language consists of thousands of ideograms, grouping and assembling the types is labour intensive and required considerable linguistic knowledge from the workers.²⁰ Movable-type printing is economically suitable for large quantities for a single run, whereas block printing is more desirable for small quantities produced over long periods of time. The latter was 'precisely the pattern of book demand and supply in traditional Chinese society', therefore movable-type did not replace block printing.²¹

Indeed major contrasts drawn between Chinese books and their European counterparts are often focused on the writing systems and different technologies used for printing. The limited number of alphabets 'enabled Europe to exploit the benefits of movable type', which was later operated by mechanical means.²² These might not be important differences because block printing simply worked better with ideograms while movable type was more appropriate for alphabets. In order to analyse knowledge formation through connections to the history of printed books we need to extend the range and scope of comparisons and contrasts to include, 'what was printed, for what kinds of reader, the prices, the distribution

¹⁴ Tsien (1985: 194).

¹⁵ Tsien (1985: 194-233); Pan (2008: 21-34).

¹⁶ Tsien (1985: 205).

¹⁷ Pan (2008: 24).

¹⁸ Pan (2008: 26); Tsien (1985: 221).

¹⁹ Pan (2008: 30).

²⁰ Tsien (1985: 220-222).

²¹ Tsien (1985: 22).

²² Goody (1978: 56).

systems, the extent to which printed matter was regulated by governments, the circulation of books in manuscript and so on'.²³

2. Literacy and Authors: Supply of and Demand for Books

In order to compare the development of literacy in China and in Europe, Baten, Buringh and Van Zanden have used the figures of book production (new book editions) per capita,²⁴ while Allen's estimates are based on urbanisation ratios. He assumes that literacy in the countryside was 5 percent and in the cities 23 percent.²⁵ Nevertheless, all scholars admit that 'data for development of literacy in the period before 1800 are quite weak'.²⁶

Before the 10th century when books were hand written their authors were limited to tiny groups of people that included aristocrats, monks, professional scribes, government officials and clerks.²⁷ Increases to the number of potential authors can be correlated to demographic changes and to the expansion of educational institutions such as private academies (*shuyuan*), community schools (*shexue*) and charity schools (*yixue*) under both the Ming and the Qing (Appendix 1 and 2).²⁸

If we take Allen's approach and compare urbanisation ratio of Europe to that of China, we find that the former surpassed from the sixteenth century onwards or as far back as the twelfth century when using Buringh and Van Zanden's estimates of urban ratios (Appendix 3).²⁹

Yet to use book production per capita to estimate literacy in China for purposes of systematic comparisons with Europe is problematical, because no comprehensive data on long-run trends of manuscript and

²³ Burke (2008: 372).

²⁴ Baten and Van Zanden (2008: 218); Buringh and Van Zanden (2009a: 433, Table 4, Table 9).

²⁵ Allen (2003: 415).

²⁶ Buringh and Van Zanden (2009a: 433).

²⁷ Idema (1974: XLVIII).

²⁸ Ho Ping-ti (1962: 194-202).

²⁹ Yet a study by Raven (2007) shows that between the mid-fifteenth and the mid-nineteenth century Britain also witnessed a 'revolution in book and print production'. Raven's data is based on the English Short-Title Catalogue (ESTC) (<http://www.bl.uk/reshelp/findhelpprestype/catbldhold/estcintro/estcintro.html>, accessed 02/12/2011), which is probably the world's most advanced national project of retrospective bibliography. The bibliographic database contains nearly 470,000 entries of all surviving early books including later editions, serials, newspapers, and ephemera printed in Britain, Inland, overseas territories under the British colonial rule and the US in the period 1473-1800. There were about 4,000 items printed around 1640 and 10,000 items printed around 1800 and the figure enormously boost with a steep take-off curve for the second half of the eighteenth century (Raven 2007: 8).

book production and consumption exists for China (Appendix 4).³⁰ One estimate is that there were 181,755 *surviving* titles in total (later editions for the same titles are not included): 12,787 titles from Western Han to Southern and Northern Dynasties (202BC-581AD) (a yearly average of 16 titles for the 783 years); 10,036 titles under the Tang (618-907) (a yearly average of 35 titles for the 289 years), 32,283 titles from the Five Dynasties to the Ming (901-1644) (a yearly average of 43 titles for the 743 years); 126,649 titles under the Qing (a yearly average of 471 titles for the 267 years from 1644-1911).³¹ The estimate for the Qing is the same as Tsien's estimate that there were '253,435 titles registered in various dynastic and other bibliographies from Han [206BC to 220BC] to the 1930s of which 126,649 were produced under the [Qing]'.³² Not all experts on Chinese book history agree with this figure. Other estimates for surviving manuscripts and books in China range from 70,000-80,000 to 200,000 titles.³³ The Qing figure is substantially high because the data are mainly based on the Qing bibliographies. For data on the Ming, one catalogue compiled under the Qing listed 15,725 works by Ming authors (a yearly average of 57 titles from 1368-1644).³⁴

These figures would not impress European historians. They would point out that from 1501 to 1550, there were 79,017 printed books in Europe (2,807 in Britain), or from 1751-1800, there were 628,801 books in Europe (138,355 in Britain).³⁵ Yet, the Chinese figures are likely to underestimate actual flows and only indicate the lower bound numbers, because the estimates overlooked many kinds of books including religious works, local compilations, and commercial publications and did not include books lost or sent abroad.³⁶

Differences between the Chinese and European languages make it difficult to think of literacy in China in the same way as the European literacy which is taken to approximate to the ability to sign one's name. Rawski has estimated that between 30 and 45 percent of China's male population and 2 to 10 percent of its female population possessed basic literacy in the eighteenth and nineteenth centuries.³⁷ Yet mere literacy does not necessarily mean that a person could produce, read, and buy books. We need to define

³⁰ For production of manuscript and printed books per century in Europe, see Buringh and Van Zanden (2009a: table 1 and 2).

³¹ Wu (1986: 27).

³² Tsien Tsuen-hsuei (1985: 190, note f).

³³ Wu (2002: 317); Wang (1982: 198).

³⁴ Zhang Xiumin (1988: 336).

³⁵ Buringh and Van Zanden (2009a: table 2).

³⁶ The European figures may also underestimate real output, because they are based on books still available in libraries (Buringh and Van Zanden 2009a: 437).

³⁷ Rawski (1979: 23).

literacies at different levels, for example, literacy for reading the *wenyan* literature (with specific vocabularies and rhythms) from that for reading colloquial literature (e.g., fictions and chapbooks). Idema distinguished 'elementary literacy', 'moderate literacy', 'full literacy' and 'high literacy' which he saw as corresponding to different income levels.³⁸ The differentiation is associated with features of Chinese language and ways of classical learning marked by three stages: memorisation of the characters; reading the Four Books and the Histories; and composition following set patterns.³⁹ Thus elementary literacy may just mean the abilities to recite a text without necessarily understanding its meaning.⁴⁰ Moderately literate people (5 percent of total population under the Qing) could perform practical tasks such as book-keeping and letter writing.⁴¹ This group of people are potential readers of books and its ratio correlates to the urbanisation ratio (5.9-6.8 under the Qing), which implies that potential consumers of books are located in the cities. Writing manuscripts and books required full literacy (1.25 percent of total population under the Qing) which means 'being able to write a composition according to a set pattern'.⁴² Yet even the fully literate could 'neither read very well nor were they particularly inclined toward literary pursuits' or 'possessed few books if any, outside of [the] Four Books, the Five Classics and a pocket-size rhyming dictionary'.⁴³ Idema further divided 'highly literate people' into three major but overlapping groups:

'those persons who actively prepared, or had once prepared, for provincial examinations, either by studying at home or in one of the *shuyuan* (academies), with a curriculum that included history and philosophy; those who served in the civil bureaucracy or on the private secretarial staff of officials; and those who had both the interest in and the means to devote their leisure to studies, whether historical, medical, mathematical, or literary'.⁴⁴

It is almost impossible to find systematic data on Idema's second and third groups. Even data for the first group is incomplete.⁴⁵ My estimates

³⁸ Idema 1974. It was usually the higher literate level, the more incomes. It is also a useful criterion for categorising literati and their status.

³⁹ Elman (2000: 263).

⁴⁰ Smith (1899: 106); Idema (1974: L).

⁴¹ Idema (1974: L).

⁴² Idema (1974: LI).

⁴³ Idema (1974: LI).

⁴⁴ Idema (1974: LII). Compared with Chinese authors, 'what is striking is the emergence in most parts of Europe by the middle of the eighteenth century of a group of more or less independent men of letters with political views of their own, concentrated in a few major cities, notably Paris, London, Amsterdam and Berlin, and in regular contact with one another' (Burke 2000: 30).

⁴⁵ I cannot find good data for the Sui and the Tang when the civil service examination system was still at its formative stage.

for the number of the highly literate people and the minimum number of potential authors is unavoidably rough (appendix 11). They are based on population records for the Northern and Southern Song, Yuan, Ming and Qing periods.⁴⁶ I calculated the rates of population increase. Idema estimated that the number in the highly literate group as 200,000 people during the Qing dynasty.⁴⁷ I assumed that ratio remained constant for Northern and Southern Song, Yuan, and Ming. The minimal number of potential authors is based on the numbers awarded the *jinshi* degrees (equivalent to a modern PhD).

To estimate literacy under the Yuan (1279-1368) is difficult. It is often regarded as a 'dark age' in Chinese history, and witnessed a massive decline in Chinese population. Under the Song, the population was in excess of 120 million.⁴⁸ The number dropped to about 70 million in the 1290s, and in early Ming around 1381 it was still less than 60 million.⁴⁹ Yet epidemics and disease rather than massacres of the Han people by the Mongols may explain the population decline.⁵⁰ Although this Yuan demographic mystery remains largely unresolved, Yuan history has been revised by many historians.⁵¹ One of their arguments is that the Mongols did not exert strict ideological control; instead they accommodated themselves to Chinese ways of governance.⁵² Chinese culture survived and continued.⁵³ Since the Yuan governmental system was a combination of Mongol, Jurchen, and Chinese institutions, the Yuan rulers found less need to recruit Han learned literati, who then engaged in other careers (e.g., in pharmacy, medicine, play-writing) to pursue their scholarly interests.⁵⁴ Furthermore, Song loyalist scholars kept away from the Yuan court and refused to take part in the civil service examinations.⁵⁵ But they remained keen to keep Zhu Xi's Neo-Confucian teaching alive by founding and maintaining academies and by publishing works they wrote and edited.⁵⁶ Despite the massive drop of total population, the Yuan dynasty

⁴⁶ The Chinese population data is subject to debate. My data is based mainly on Chao (1986). I chose the median years of the dynasties and estimated the number of population for that middle year based on data available for the years close to that middle year.

⁴⁷ Idema (1974: LII).

⁴⁸ Chao (1986: table 2.3).

⁴⁹ Langlois (1981: 15, note 34); Chao (1986: table 2.3).

⁵⁰ Langlois (1981: 20).

⁵¹ For a summary of the revisionist studies of the Yuan history, see Langlois ed. (1981). For a recent study on a Song-Yuan-Ming continuity, see Smith and Von Glahn eds. (2003). For a continuity from the Yuan to the Ming, see Brook (2010).

⁵² Langlois (1981: 12, 16).

⁵³ De Rachewiltz (1966: 142).

⁵⁴ Langlois (1981: 15-18).

⁵⁵ Only 1,136 men obtained *jinshi* degrees under the Yuan compared with other periods (e.g., 18,694 awards under the Southern Song) (Appendix 11).

⁵⁶ Chia (2003: 302). On the increasing number of private academies under the Yuan, see Appendix 2.

witnessed an increased involvement of *Shuyuan* (private academies) in publishing and the growing market for medical works (prescriptions), household encyclopaedias, and illustrated historical fiction.⁵⁷ There was no overall decrease in the number of Classics and related works printed.⁵⁸ Nevertheless, the Chinese educational system only trained a tiny group of elites for purposes of governing the empire, and the spread of literacy did not keep up with population levels.

3. Costs of Book Production: The Printing Industry and Book Prices

Book producers and printers included the central government and its local agencies, commercial workshops, Buddhist monasteries, private academies, and private individuals. Printing centres increased in line with urbanisation. By the mid-Northern Song, Kaifeng, Hangzhou, Sichuan, and Fujian became the leading regions for printing and book trade.⁵⁹ Under the Southern Song and the Ming, Jianyang in Fujian printed the largest number of books and was also the biggest book market.⁶⁰ From the Yuan onward, printing centres began to be separated from book markets, and this trend continued into the Ming. Book markets were concentrated in Beijing, Nanjing, Suzhou and Hangzhou, while printing centres were concentrated in Jiangsu, Zhejiang and Fujian.⁶¹ Literati and popular print culture emerged under the late Southern Song and continued under the Yuan and expanded during the Ming.⁶² String binding began to be used from the late Yuan and early Ming when sophisticated colour printing and the use of calligraphic styles in imprints emerged.⁶³ By the middle of the Ming dynasty, the number of commercial imprints increased dramatically and a middlebrow readership expanded.⁶⁴ Nevertheless, scribal manuscripts continued to play an important role.⁶⁵ An decline in the publishing industry in Fujian (e.g., Sibao) began in the mid of the nineteenth century when western mechanised printing technologies introduced to China and Guangzhou and Shanghai became the printing centres for that region.⁶⁶

57 Chia (2003: 298, 302).

58 (Chia 2003: 301).

59 Fang (2008: 43).

60 Fang (2008: 44).

61 Fang (2008: 46).

62 Chia (2003: 299, 327); Chow (2004: 21-23).

63 Zhang Xiumin (2009: 155); Chia (2003: 326).

64 Chia (2003: 303-304).

65 Two of the largest book collection projects in Chinese history – the *Yongle Dadian* under the Ming and the *Siku Quanshu* under the Qing – were produced only in manuscript. By contrast, chapbooks were printed only in commercial editions and nothing was in manuscript (Idema, 1974: LXI).

66 Chow (1996: 58); Zhang Xiumin (1989: 589-595).

The expansion of printing and publishing industries widened career opportunities for the better educated especially those who preferred not to embark on the long and tedious process of preparing for and taking the exams, or those who did not have sufficient financial support from their families to support their studies. Men who 'abandoned Confucian studies for business' (*qi ru cong shang*) were labelled as 'scholar-merchants' or 'Confucian merchants' (*ru shang*).⁶⁷ Publishing for them was a profession that could link 'its merchant practitioners to the world of learning, perfuming their morally questionable search for profit with the "scent of books"' and thereby garner cultural capital to lift their social status.⁶⁸ Nevertheless, many still disparaged this profession and regarded profits as 'vulgar'.⁶⁹ Publishing operated as family businesses. Wealthy publishers would usually buy land, build a mansion, hire scholars to prepare their sons and grandsons for the state's examinations, and engaged in other charitable activities that could enhance their status as gentry.⁷⁰ Agglomerating profits for future investment was a secondary concern for those book merchants. Furthermore, although Commercial printing contributed to the spread of new ideas in particular Wang Yangming's interpretations of Neo-Confucianism published during the late Wan-li reign period (r. 1572-1620).⁷¹ Nevertheless Chinese book publishers and booksellers did not work as closely as their British counterparts in collaboration with authors to produce and circulate many books that helped to shape mentalities of readers.⁷²

Although Idema argued that Chinese books were luxuries for the rich,⁷³ he did not distinguish prices paid for the majority of books from the costs of rare editions for collectors and bibliographers which could amount to hundreds of taels.⁷⁴ Chow has reconstructed the range of book prices and costs of book production for the late Ming period to show that from the Wanli period (r. 1572-1582) on the cost of book production declined with the fall in the costs of paper production and wages.⁷⁵ By the mid seventeenth century, the price of paper was 0.026 taels per one hundred sheets, the wages of woodblock carvers was 0.02-0.05 taels per 100 characters, pear woodblocks cost 0.03 taels per block and the more

67 Brokaw (1996: 62-63).

68 Brokaw (1996: 63).

69 Brokaw (1996: 65).

70 Brokaw (1996: 69-71).

71 Chow (1996: 121, 133).

72 Sher (2006: 607).

73 Citing Weng Tongwen (1967), Idema (1974: VIII) pointed out that from the Tang to the Ming times the price of a printed book was in general one tenth of that of a handwritten copy.

74 Chow (2004: 38-39). 1 *tael* = 37 grams of silver.

75 Chow (2004: 19-56; 2010).

expensive higher quality jujube wood cost 0.1 to 0.4 taels per block. The overall cost of printing single volume was 0.011 taels (the cost of paper 70.2%, the cost of woodblock carvers' labour 24.4%, and the cost of woodblock 5.4%).⁷⁶

Chow suggests that books below one tael became affordable as a common commodity to poorer literati and to artisans (Appendix 5).⁷⁷ He also points that official stipends are not a good index of the actual income of Ming officials because they received various kinds of allowances (e.g., forty to fifty taels for new furniture) and miscellaneous charges plus a government residence. Thus a county magistrate's annual income could reach up to five hundred taels (Appendix 6).⁷⁸ Official salaries were, however, allocated to support a large network of people including servants, minor officials, as well as their disciples. Thus a provincial governor under the Qing might require a minimum 6,000 taels annually to support his office.⁷⁹ Elementary school teachers could earn more than forty taels a year in addition to meals and gifts paid by students as marks of respect during festivals and holidays.⁸⁰ Wages reveal real standards of living if and when they are deflated by prices of consumer goods⁸¹ and Chow argued that books were not relatively expensive.⁸² Again Chow did not take the expanses of the household and family budget into account (Appendix 7). One's wage might be needed to support an entire family.⁸³ Chinese books were more affordable for the educated elites rather than to artisans and other groups of common people, and look more expensive than their European counterparts.⁸⁴ For example, one book worth one tael in mid-eighteenth century China would cost 0.5 working days for officials, 6.3 working days for school teachers,

⁷⁶ Chow (2004: 33-38; 2010: 10-11). The Jesuit missionary Matteo Ricci noticed that Chinese books were cheaper than European ones. By the late Ming, paper-making (especially bamboo paper) had become one of the most important handicrafts of western Fujian (Chow 1996: 53; Chow 2004: 31-33). Chinese printers paid much less for paper than their European counterparts (Chow 2004: 28).

⁷⁷ This excludes rare editions of collectors which were luxuries and did not reflect the real market price. Religious imprints were often sent for free or low prices (Chow 2010: 7).

⁷⁸ Chow (2004: 48).

⁷⁹ Zelin (1984: 37).

⁸⁰ Chow (2004: 50). Rawski's data (1979: 56-58) shows regional variations of elementary school teacher's salaries ranging from 8.6 taels to 80 taels from ca. 1671 to the late nineteenth century. The extra monetary gifts could amount to 39% of the teacher's salary in one clan school (Rawski 1979: 55).

⁸¹ Allen (2005: 112).

⁸² With 0.12 taels, one could purchase six catties (three kilograms) of pork or three catties of peach or plum, but it was not enough to pay for one catty of spinach nor a big goose which cost 0.2 taels. For Ming prices, see also Huang Miantang (1985: 346-372).

⁸³ Male incomes hardly covered taxes extortion and bribes. Women had to work hard to pay taxes. See Elvin 1998.

⁸⁴ Some parts of Europe especially England generated higher real wages than Asia. Yet since prices were lower in China, low Chinese silver wages do not imply that the standard of living was lower in China (Allen 2005: 122, 124).

and 15.6 working days of artisans, whereas in Europe one book would cost 0.22 working days for unskilled workers in the mid 1600s.⁸⁵

4. Access to and Control over the Production and Circulation of Written and Printed Words

Libraries are important cultural and educational institutions for the diffusion of knowledge. In China books were stored in imperial libraries, private libraries, monasteries, schools and academies (*shuyuan*).⁸⁶ Large scale projects for book collection in the form of encyclopaedias were patronised by the imperial courts.⁸⁷ Ming emperors fostered publication projects. The most famous the *Yong Le Da Dian* consisted of 22, 211 *juan* (text was divided into scrolls) ordered by the Yongle Emperor (Ming Chengzu, r. 1403-1424) was compiled by eminent 2, 180 scholars of the day. Unfortunately, only three copies of this manuscript were kept in Beijing and Nanjing and two were destroyed by fire during the downfall of the Ming. The remaining copy was subsequently damaged by fire and looted when the foreign troops invaded Beijing in 1900.⁸⁸ The largest scale official book collection under the Qing, the *Si Ku Quan Shu* (or the 'Four-Treasure Library'), was compiled under the Qianlong Emperor (r. 1735-1796).⁸⁹ The exact purpose of this project is unknown and continues to be debated --whether it was to preserve literature, to find a way to identify and weed out all anti-Qing works, or to shift the attention of scholars from political issues to purely scholastic activities.⁹⁰ Significance was clearly assigned to different kinds of books. One group consisting 140 works was entitled *Jiu zhen ban cong shu* ('assembled treasures'). It dealt with governance and ethical issues and was printed by wooden movable type. Titles of the less important works were recorded in the *General Catalogue (si ku quan shu zong mu)* which consisted of 660 titles in classics, 570 in history, 930 in philosophy, and 1,280 in belles-lettres as well as a small portion of works written by the Jesuits.⁹¹ The imperial government made no attempts to disseminate the less important works through printing. Most books were transformed into manuscript form in order to make the emperor's book collection as precious as possible.⁹² Furthermore, neither the imperial court nor private book col-

⁸⁵ Appendix 7; In Europe in the 1600s, one chapbook cost 2 pence, and the daily wages for unskilled workers range from 9 to 11 pence (Dittmar 2011: 19).

⁸⁶ Ren 2001.

⁸⁷ Weber (1920, vol. 1: 339).

⁸⁸ Taam (1935: 5-6).

⁸⁹ The compilation of the 'siku quanshu' started from 1773 and lasted for ten years.

⁹⁰ Taam (1935: 28). Books consisted of the remaining volumes of the *Yong Le Da Dian* preserved at the Han-lin Academy; works published under imperial patronage; books from the shelves of the different palace buildings; copies purchased by the provincial authorities and borrowed from private collectors; ordinary editions from various sources (Taam 1935: 33).

⁹¹ Taam (1935: 37).

⁹² Taam (1935: 33-34).

lectors seem to have been concerned to acquire knowledge from outside the empire. Despite the Kangxi emperor's personal interest in scientific and technical knowledge as conveyed by Jesuits, he retained very few books in European languages in his imperial library. No eminent private collectors made attempts to possess books in European languages.⁹³

Private book collection emerged under the Yuan and had become fashionable among the literati during the late Ming.⁹⁴ The best Ming libraries were private collections.⁹⁵ They included the *Tian Yi Ge* of the Fan family at Ningbo, and *Ji Gu Ge* of the Mao family at Jiangsu.⁹⁶ During Qing times (1644-1911), private collectors created more than 500 famous libraries and more than half were located in Zhejiang and Jiangsu provinces.⁹⁷ Book collection resembled art collecting. Private collectors appear to have accorded top priority to acquiring rare Song and Yuan editions. Few made efforts to buy books dealing with 'scientific' subjects.⁹⁸ Most were reluctant to make books accessible to outsiders even their close friends, let alone the public at large.⁹⁹

Chinese libraries began to increase rapidly in scale and number from the mid-fifteenth century onwards as the outcome of the growing availability of books, the commercialisation of publishing, the expansion of local schools, and as a reflexion of state policies concerned to control and disseminate knowledge. Some libraries had already been attached to official schools in provincial or prefectural capitals under the Song, but they were rare prior to 1395.¹⁰⁰ Expansion continued under the Yuan and Ming dynasties.¹⁰¹ The Hongwu emperor (r. 1368-98) and his successors were keen on establishing an official canon of knowledge by distributing palace editions of appropriate books and texts for four categories of people, namely, literati, farmers, artisans and merchants.¹⁰² For students, Zhu Xi's teaching of Neo-Confucianism was established as canonical.¹⁰³ Most of the books kept in school libraries were distributed by the state and core Ming texts consisted of the Classics (200 *juan*), legal, administrative, and ritual texts (276

⁹³ Taam (1935: 92).

⁹⁴ Ren (2001: 14).

⁹⁵ Brook (1996: 93).

⁹⁶ A catalogue compiled in 1808 of the collection of the *Tian Yi Ge* shows that its collection of 4, 094 different works fell into four main categories, namely, classics, history, philosophy and belles-lettres (Taam 1935: 8).

⁹⁷ Taam (1935: 47).

⁹⁸ Taam (1935: 93).

⁹⁹ This is a contrast with the donation of books for the public use in Europe in that period. Sir Thomas Bodley (1545-1613), for example, bequeathed his whole collection for founding the Oxford Library.

¹⁰⁰ Brook (1996: 94, 102).

¹⁰¹ Brook (1996: 94). The Hongwu emperor (r. 1368-98) strongly promoted the expansion of nationwide local official schools (Brook 1996: 105).

¹⁰² Brook (1996: 103-104).

¹⁰³ Brook (1996: 103).

juan), hortatory literature (moral admonitions and instructions 91 *juan*), and geography and history texts (309 *juan*).¹⁰⁴ Patrons for building libraries were officials rather than local gentry.¹⁰⁵ Since the Confucian system of knowledge was controlled by the state, school-libraries were sites for revering the canon rather than places and ways to open men's minds to innovation.¹⁰⁶

Losses of books occurred through imperial proscriptions, censorship and transfers of books from private collections to large governmental collection projects.¹⁰⁷ Chow argues that the Ming government did not have effective institutions for censorship and publishers and printers were not required to register with the government.¹⁰⁸ He ignores the issue of governmental regulations for publishing from the tenth century onwards.¹⁰⁹ The early Qing, 'literary persecution' (*wenzi yu*) was serious. Even the use of a word that might hint loyalty to the Ming or an attack on the Qing rule could lead to the slaughter of not only the author but his entire lineage.¹¹⁰ A single case in the early Qing might sometimes put the lives of as many as 13,000 people at risk.¹¹¹ Censorship was no less strict. Two thousand titles published during the late Ming period from 1567 to 1644 were wiped out by the 'Four-Treasure Library' project under the Qianlong reign.¹¹² 'Within the years from 1774 to 1782, the burning of prohibited books took place twenty-four times and more than 13,000 volumes were destroyed'.¹¹³ Furthermore, woodblock printing made Chinese books 'more vulnerable to depreciation and depletion than European books'.¹¹⁴ Orders could easily be decreed to destroy blocks, while the fact that many books remained in manuscript form made them vulnerable to fire, war and looting. Censorship also remained strict in Europe. Yet, in some polities it became more relaxed especially in the Dutch Republic, England during the Civil War and again after 1688, and in Sweden during the 'age of liberty' 1766-1772.¹¹⁵

¹⁰⁴ Brook (1996: table 2).

¹⁰⁵ Brook (1996: 112-113). The cost of building a library in the 1570s was about 1,000 taels (Brook 1996: 111).

¹⁰⁶ Brook (1996: 117). In Europe since the early seventeenth century, certain private or public libraries became arenas for 'the advancement of universal learning' (Burke 2000: 56).

¹⁰⁷ The burning of books by the First Emperor of the Qin in the year 249BC was a huge destruction of cultural assets that China then possessed.

¹⁰⁸ Chow (1996: 135).

¹⁰⁹ Chan 1983. For example, laws and regulations under the Tang and the Song prohibited the unauthorised distribution of works including the almanacs, astronomical charts, government statutes, national histories, religious writings and unorthodox literature (Chan 1983: 2).

¹¹⁰ Taam (1935: 15).

¹¹¹ Liang (reprint 2004: 16).

¹¹² According to the *Index Expurgatorius*, 756 were characterised as offending, 1, 531 as prohibited, 146 as to be burned entirely, and 182 as to be burned in parts. See Taam (1935: 41).

¹¹³ Taam (1935: 15).

¹¹⁴ Chia and De Weerd (2010: 15).

¹¹⁵ Burke (2000: 145).

III. Supply of and Demand for Useful and Reliable Knowledge

Given that the formation and diffusion of useful and reliable knowledge is a significant process behind the emergence of modern economic growth, shifts in the locus for its generation may help to explain the 'great divergence' between China and Europe. For Europe histories of printing and book production have provided indicators of the accumulation and diffusion of useful knowledge and been used to track growth towards a knowledge economy.¹¹⁶ However, studies of how useful knowledge was generated, accumulated and circulated by printed books and their relationship with long-term political, social and economic transformations for both China and Europe now need to be addressed.

1. Types of Written and Printed Knowledge

It is difficult to quantify printed books and manuscripts dealing with 'useful' knowledge throughout the Chinese history because the extant data is sketchy and the system of categorising knowledge was complex and it is difficult to distinguish knowledge (books) into more or less useful categories.¹¹⁷ Since the Eastern Jin dynasty (316-420), Chinese collections of books were divided into four categories: *jing* (经 Confucian classics, 15.5%), *shi* (史 history 22.74%), *zi* (子 philosophy, 26.7%), and *ji* (集 literature, 35.05%) (Appendix 8).¹¹⁸ This way of classifying books was adopted by the Sui Emperor Yang Guang (r.604-618) and by rulers of the following dynasties. The *Four-Treasury Library* also adopted this system. The category of *zi* is where useful knowledge can be primarily located. Publications in Jianyang from the Song to the Ming shows that Classics and Histories constituted nearly half of all books printed in China (Appendix 9).¹¹⁹

In early modern Europe, knowledge was also classified in a complex ways. Distinctions were made between theoretical and practical knowledge (or between 'science' and 'art'), between public and 'private' knowledge (including the secrets of nature), between legitimate and forbidden knowledge, between higher and lower knowledge, between classical and 'useful' knowledge (e.g., processes of production), between

¹¹⁶ Van Zanden 2009.

¹¹⁷ An attempt to quantify scientific books from the earliest times to the close of the nineteenth century on a global scale has been made by Gascoigne (1984), although its focus was on Europe. The book (pp. 64-67) recorded only 85 titles of Chinese scientific books.

¹¹⁸ Compare with the increasing use of full alphabetical order in the classifying system in early modern Europe, see Eisenstein (1983: 64-73). Historical books were another major scheme for classifying knowledge. They were the places where useful knowledge was located.

¹¹⁹ Chia (2003: 289).

general and specialised knowledge, between qualitative and quantitative knowledge and so on.¹²⁰ Written texts were also classified for university degrees and curricula: grammar, logic and rhetoric for the *trivium*, arithmetic, geometry, astronomy and music for the *quadrivium*, poetry, astrology, divination and magic, geography, history, mechanical arts, natural philosophy, metaphysics, moral philosophy, 'economic' philosophy, politics, higher degrees in law, medicine and theology.¹²¹ Classification for higher forms of education separated knowledge into specialised subjects.

2. Manuscripts and Books Dealing with Useful Knowledge

The separation of knowledge into scientific and technical forms is a relevantly recent phenomenon.¹²² In pre-modern China, more inclusive approaches to classification prevailed.¹²³ Thus no clear distinctions were made between sciences or knowledge about the natural world and other kinds of knowledge which could be based on intuition, aesthetic perception and ethical commitments. Investigations into the natural world were mixed up with those about supernatural and strange occurrences. Subjects concerned with useful knowledge included calendrical astronomy, harmonics, mathematics, medicine, agriculture and horticulture, techniques, divination, alchemy, geomancy, and military technology and other less clear cut matters important for governance or statecraft such as criminal justice, financial administration, and taxation. Discussions of such subjects were dispersed within Confucian classics and commentaries, official dynastic histories, biographies of scholar-officials, encyclopaedias (*leishu*), as well as medical case histories (*yi'an*), handicraft regulations, and technological handbooks.

Needham's *Science and Civilisation in China* provides historians with a useful source for identifying books and manuscripts dealing with useful knowledge. Each volume contains an appendix of bibliographies of 'Chinese books published before 1800' (including manuscripts). They include Chinese and English titles, dates of publication, authors or editors, and notice of whether the work still exists.¹²⁴ My database selected books that

120 Burke (2000: 82-90).

121 Burke (2000: 92-93). The first printed bibliography was made in 1545.

122 An all-embracing natural philosophy and natural history in curricular for higher education in late 17th and 18th century Europe began to be divided into separate scientific disciplines (Gascoigne, 1995: 576).

123 Kim (2010: 208).

124 Some appendices also contain Chinese books after 1800 and before 1900.

were probably related *directly* to 'useful and reliable knowledge' (URK).¹²⁵ Needham did not, however, distinguish works containing proto-scientific investigations and technologies from other kinds of books such as Confucian classics and histories. In many cases we cannot tell what a book contains from its Chinese titles – words were chosen to make the title elegant rather than as a reference to that the contents of a book. Fortunately Needham translated the titles into English which offers slightly more information. He used modern categories and divided his volumes into mathematics, physics, biology etc. I have rearranged the categorisation by referring to both Needham's works and the traditional Chinese system and included books dealing with: mathematics (43), astronomy (52), nautical matters and shipbuilding (16), mechanical engineering (8), civil engineering and water control (41), military technologies (78), textiles (36), food (65), agriculture (49), disaster relief (11), paper and printing (19), medicine and health (231), metallurgy and mining (7), crafts (13), cosmography and general studies on the natural world (45), commerce and industry (8), geography (154), chronology (7), architecture (21), ceramics (12), and biology (143). The total selected came to 1,080 (Appendix 11). For statistical purposes, each book has been allocated just one entry in each category, although it could cover multiple subjects.¹²⁶ Appendix 10 indicates that production of such books per capita increased continuously from the Northern Song to the mid-Ming with a take-off curve from the Yuan to the mid-Ming. However, after reaching its climax in the mid-Ming, the number declined.

These numbers look smaller compared with European data on specialised scientific books. According to Gascoigne (1984), for the Middle Ages (c. 560-c.1400), there were 254 such titles (written in both Latin and the European vernacular); from ca. 1450-1700, there were 1,546 titles (pp. 89-214); there were 12,889 titles from ca. 1640 to ca. 1859 (pp. 225-1020), including general science (162); various fields (330); Mathematics (1079); Astronomy (998); Mechanics (313); Physics (1202); Chemistry (1675); Mineralogy and crystallography (293); Geology (1403); Other earth sciences (470); Biology in general (19); Microscopy (48); Natural history (345); Scientific expeditions (36); Botany (1318); Zoology (1213);

¹²⁵ I adopt Professor Patrick O'Brien's definition of URK as 'all forms of knowledge that directly or indirectly maintained or raised the productivity of the inputs (land, natural resources, capital and labour) utilized to produce final outputs/outcomes, including consumption goods, health, security, success in warfare etc'. Confucian classics included discussions of URK. But since they are not specialised studies of the natural world, they were excluded from my database. Books on alchemy are also not included since most were about producing elixirs for immortality. These might be useful but were clearly not reliable. See Butler and Glidewell (2008: 532).

¹²⁶ For example, both agricultural treatises and astronomical works could include discussions on mechanical instruments. Works on geography could touch upon studies of biology.

Evolution and heredity (71); Human anatomy (541); Embryology (human and comparative) (122); Cell theory and cytology (33); Physiology (human and comparative) (545); Microbiology (161); History of science (281) (Appendix 12).

3. Dissemination of Useful Knowledge: Illustrated Books, Encyclopaedias and the Changes to the Views on Nature

The rise of the idea of public knowledge accompanied the diffusion of the printing press in early modern Europe.¹²⁷ Long observed that in the sixteenth century printing facilitated the expansion of publications on mining, metallurgy, architecture, pottery and other crafts which testified to an increase in communication and collaboration between artisans and learned elites.¹²⁸ Eamon agreed that 'the sixteenth century was an age of "how to"...[when] the "secrets of nature" were revealed to the general public through printed books'.¹²⁹ The combination of *technē* (manipulation of machines and instruments) and *epistemē* (theoretical knowledge) contributed to the emergence of the new sciences of the seventeenth century.¹³⁰ Nevertheless in the same period China also witnessed a popularisation of knowledge and the bringing together of theoretical and tacit knowledge through, for example, a proliferation of encyclopaedias and the use of illustrations (*tu* 图) to convey textual information.

Under the Song, Yuan, Ming and Qing writings on 'the investigation of things' (*gewu*) expanded.¹³¹ For example, the *gezhi congshu* (a collection of books on the 'investigation of things' comprising 293 items concerning all classics, history, law, Daoism, Buddhism, divination, astrology, geomancy, longevity techniques, medicine, agriculture, tea technology, etc.) was compiled by Hu Wenhuan in 1595.¹³² *Tiangong kaiwu* (天工开物 *The exploitation of the works of nature*) written by Song Yingxing (宋应星 1587-1666?) under the Ming was a revealing example. He had passed through the civil service examinations at the county level and became an 'advanced scholar' (举人) but failed his subsequent higher-level exams many times. At the age of forty seven, he became a minor official in a county in charge of education and wrote books to supplement his income.¹³³ He published more than ten works on scientific and

127 Eamon 1994; Burke 2000: 83; Long 2001.

128 Long (2001: 246).

129 Eamon (1994: 10-11).

130 Long (2001: 2).

131 Under the Ming, writings on 'statecraft' (*jingshi*) also expanded. See Mingdai shi yanjiu weiyuanhui 1986.

132 The conception of *wu* is very broad, not just about things but also about human affairs and events.

133 For the explosion of illustrated books, see e.g., Clunas (1991: 52), Hegel (1998: 5).

technical topics, politics and society and history.¹³⁴ His major work *Tian-gong kaiwu* published in 1637 included not only discussions of agriculture but also descriptions of the production of sugar, textiles, ceramics, salt, colas, various metals and precious stones etc. It was written not just for educated elites but also for a broader readership including merchants, farmers, artisans and craftsmen. Thus the advertisement for the second edition of the book contained a statement that the book included 'all kinds of money-making and ever-useful professional secrets and essential instructions on agriculture, weaving, manufacture, mining and working of metals and treasures'.¹³⁵ The book contains illustrations of technologies and depictions of productive activities using skills, technologies and manipulations of natural resources.¹³⁶ Alas the book was not taken seriously either by the imperial court or the literati. It was not included in the '*Siku quanshu*' (The 'Four-Treasure' Library or the Comprehensive Library in Four Classes) compiled by decree of the Qianlong emperor (乾隆r. 1735-1796). It failed to be widely disseminated, and was subsequently lost.¹³⁷

Song relied upon block carvers whose skills were deeply influenced by Chinese artistic and the quality of the illustrations was not high.¹³⁸ As Golas pointed out, Chinese painting after the Song 'moved away from realism and specificity toward a dominant emphasis on suggestion, impressionism and expressivity'.¹³⁹ Accurately portraying complex machinery or production processes then became a more complicated and difficult to achieve. Artists in late medieval and Renaissance Europe recognised this challenge and constantly worked for an improvement to the accuracy of the illustrations, but Song found no pressing need to deal with this problem.¹⁴⁰ His writings seem to have been motivated by moral and humanitarian considerations rather than by any purely intellectual investigations into a separate natural world. He was more concerned with finding a pleasing way to combine text and illustrations in order to depict a production process rather than analyse it with the clarity and accuracy necessary to understand and diffuse technologies.¹⁴¹ Golas has concluded that 'limited success in picturing technology of any complexity acted as a major impediment to technological creativity in late imperial China'.¹⁴²

134 Pan (1990: 234-235; chapter 6).

135 Golas (2007: 585).

136 Golas (2007: 585).

137 In the 1920s China obtained copies of the book from Japan. Later the Beijing Library recovered the original copy from a private collection.

138 Chow (2004: 25).

139 Golas (2007: 591).

140 Golas (2007: 591).

141 Golas (2007: 586, footnote 80).

142 Golas (2007: 591).

Finally it is necessary to survey and compare a book genre that is clearly important for knowledge formation, namely encyclopaedias (*leishu*), designed to classify knowledge drawn from a wide range of sources. The *Explication of Names* (*shiming*) written by Liu Xi ca. 200 AD already included features of *leishu*. The *Imperially Reviewed* (Huanglian) edited by Liu Shao under the Sanguo (Wei) period (229-265) is regarded as the earliest Chinese encyclopaedia. Forty-eight encyclopaedias appeared under the Tang and 307 under the Song. According to the *General Catalogue of the Four-Treasure Library*, compiled under the Qing, there were 15 encyclopaedias appeared during the Five Dynasties (907-960), 66 under the Song, 7 under the Yuan, 137 under the Ming and 55 under the Qing.¹⁴³ Developments in printing under the Tang and Song facilitated the publication and collection of such books and promoted schemes for the classification of knowledge. Tang and Song emperors collected books and participated directly in major publishing projects. The Imperial Library had the most comprehensive and authentic copies of books published in China.

Leishu were hard to classify as being in the *jing*, *shi*, *zi*, and *ji* categories mentioned above. They were compiled to preserve literature and to facilitate research. They suggested strategies for good governance, offered advice for the candidates' preparing for exams and information for practical uses as household handbooks and manuals.¹⁴⁴ Although *leishu* has been translated into English as encyclopaedias, they differ from western models. For example, their compilers emphasised the original sources behind the arrangement of categories and sections. More information was supplied on literary, history and human affairs, and less attention was given to natural phenomena. Once published, there were few revisions or new editions. Indexes do not seem helpful.

Under the reign of the Tang emperor Gaozu (高祖r. 618-626), Ouyang xun (欧阳询557-641) scholars compiled *Yiwen leiju* (艺文类聚Classified Excerpts from Ancient Writers) published in 624. It had 100 *juan*¹⁴⁵ 卷 and 45 sections (*bu* 部) including heaven, earth, rulers, rituals, officials, politics, military issues, clothes, food, birds, disasters and other categories. There were more than 730 subsections (*mu* 目). For example, under the section of heaven, there were subsections on the sun, the snow, the wind and the rain. Other Tang official encyclopaedias included *Tanghuiyao* (唐会要Institutional History of the Tang dynasty) and *tongdian* (通典Com-

¹⁴³ Zhuang (1983: 4, 7-8).

¹⁴⁴ Encyclopaedias contains excerpts of classical and historical texts were compiled for examination candidates.

¹⁴⁵ Texts were divided into scrolls.

prehensive Institutions). Under the order of emperor Taizong of the Song (宋太宗r. 976-997). Li Fang (李昉925-996) and other scholars compiled the *Extensive Records of the Grand Tranquillity Reign* (*Taiping guangji* 太平广记)¹⁴⁶ between the years 977-978. It is an anthology of tales, novellettes, dreams and ghost stories from the Han to early Song dynasties. It also contained information on literature, painting, medicine, grass and trees, animals and objects. It included 500 *juan*, 92 categories (*lei* 类) and 150 specific sections (*mu*). For example, under animals, there are sections on cows, horses, sheep, dogs, and pigs. Li Fang also compiled an *Imperially Reviewed Encyclopaedia of the Grand Tranquillity Reign* (*Taiping yulan* 太平御览) between the years 977-983. It was the largest encyclopaedia of Chinese knowledge available in print at that time. It contained 1,000 *juan*, 55 sections and 4,558 subsections selected from 2,579 books. It was arranged into 5 general categories or the orders of heaven (*tian* 天), earth (*di* 地), human (*ren* 人), events (*shi* 事) and objects (*wu* 物). Sections and subsections were divided according to four categories of *jing*, *shi*, *zi* and *ji* mentioned above. Under the subsections, materials were arranged in chronological order covering numerous areas including heaven, earth, emperors, officials, rituals, military affairs, punishment, medicine, flora and fauna.¹⁴⁷ Yue Shi (乐史930-1107) compiled the *Record of the World during the Grand Tranquillity Reign* (*Taiping huanyu ji* 太平寰宇记) between the years of 976-983. This book contains 200 *juan* and dealt with local economies, customs and geographies of the Song. It also includes detailed information on agriculture, forestry, husbandry, fishing, and herbs and medicine. Chinese classification systems do not, however, distinguish useful from other kinds of knowledge such as records of dreams and ghost stories.

Since the Yuan encyclopaedias which emphasised categories for 'practical purposes' or household uses proliferated. They functioned as manuals for everyday life, with information ranging from astrological charts, farmers' almanacs, rules of etiquette, forms for legal contracts to word puzzles and jokes, and guide books.¹⁴⁸ Such works were cheap and usually readable by both well-educated and semi-literate customers.¹⁴⁹

¹⁴⁶ *Taiping xingguo* (太平兴国Ascended Nation in Grand Tranquillity) is the name of a period (976-84) under the Song emperor Taizong. Many encyclopaedias were compiled and finished during this period, and their names often began with 'Taiping' (Grand Tranquillity).

¹⁴⁷ On an index of the *Taiping yulan*, see Qian 1934.

¹⁴⁸ Chia (2003: 310).

¹⁴⁹ Chia (2003: 310).

IV. Concluding Remarks

This paper discussed the long-term trends book production and circulation in the Chinese empire, compared them to Europe, and speculated about their connections to long-term socio-economic change in China. Through the examinations of printing technologies, literacy and urbanisation, books prices and access to and control over knowledge, it concludes that the circulation of books in China was substantially smaller than in Europe. It has also analysed the demand for and supply of books containing potentially useful knowledge. The limited data available shows that there was continuity under Song-Yuan-Ming dynasties and that could be correlated with slow but steady technological advance over these centuries.¹⁵⁰ On a per capita basis, growth of book production and circulation declined significantly from the Qing onwards. The decline can be linked to stronger state control over the dissemination of knowledge which can be dated to the early Ming but intensified under the Qing, even though commercialisation of book production expanded under both dynasties. Hierarchy in the Chinese knowledge system is apparent. Books on useful knowledge constituted but a small share of a larger number of books produced, published and preserved throughout the Chinese history. Priority was accorded to Confucian classics and histories. Books may have played a more limited role than was the case in Europe as conduits linking theoretical to tacit knowledge.

A comparative approach to knowledge formation through the history of books is a way into appreciating one input for innovation in China and Europe.¹⁵¹ The data 'allows us to see more clearly than before the manifold ways in which books express, embody or illustrate the culture in which they are produced and consumed'.¹⁵² My reading on Europe is incomplete and I intend to write a revised draft by way of more systematic comparisons between the two cultures. However, a tentative conclusion at this stage would be that human capital formation probably proceeded at a slower rate in China and significantly declined from ca. 1650 onward in terms of generating, disseminating and acquiring useful knowledge.

¹⁵⁰ Smith and Von Glahn eds. 2003.

¹⁵¹ For comparative approaches to the history, see e.g., Burke 2008, Buringh and Van Zanden 2009a. This chapter is limited to a comparison between China and Europe. But it could be heuristic to conduct a multilateral comparison by including the Islamic and Japanese worlds. For the history of books in the Islamic world, see e.g., Atiyeh ed. 1995; Hanna 2003. On the history of books in Japan, see e.g., Kornicki 1998; Berry 2006.

¹⁵² Burke (2008: 371).

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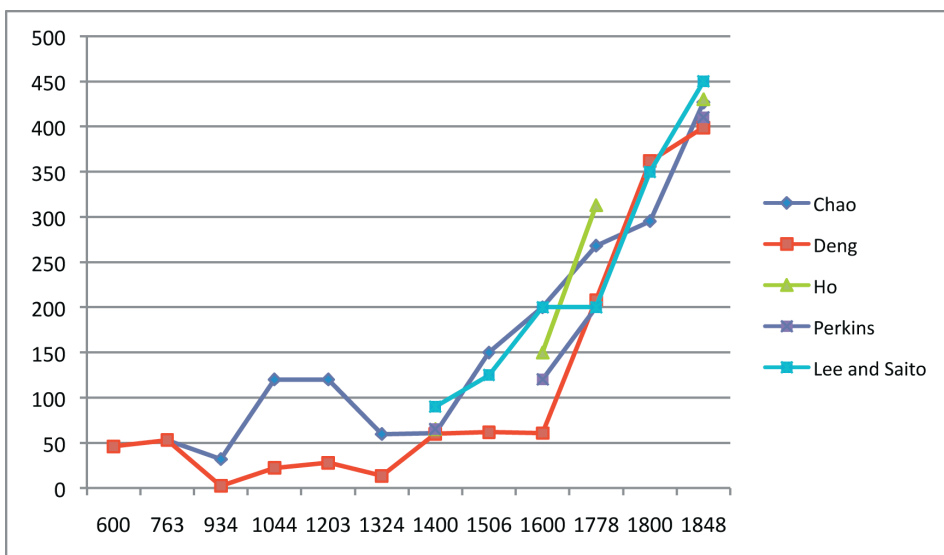
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Appendix 1: Data on Chinese Population



Sources: Chao (1986: 41); Deng 1999 (360-362); Perkins (1969: 216); Ho (1959: 257-280, 281-282); Lee, Camprell and Wang (2002: 600).

Appendix 2: Establishment of Private Academies during the Song, Yuan, Ming and Qing Dynasties

Dynasty	No. of Academies	Years	Annual Index	Population (million)	No. per one million inhabitants
N. Song	56	166	Less than 1	121	Less than 1
S. Song	261	153	1.71	120	2
Undated Song	108	--	--	--	
Total: Song	425	319	1.33	--	
Yuan	320	88	3.64	60	5
Ming	926	250	3.70	150	6
Qing	4,365	267	16.35	268	16

Source: Number of academies are based on (Elman 2000, Table 1.6).

Appendix 3: Estimates of Urbanisation Ratio, Eighth to Eighteenth Centuries

1. Rozman's Urban Ratios for China from Tang to Later Qing

Dynasty	Reference Year	Rozman's Urban Ratio (% of total population)	Ratio of Cities with 10000 inhabitants or over	No. of Cities with 10000 inhabitants and above	Rozman's population Total for China (million)
Mid Tang	762	4.7	3.0	50	100
Mid Song	1120	5.2	3.1	91	120
Mid Ming	1506	6.5	3.8	112	130
Early Qing	1650	6.8	4.0	136	150
Later Qing	c. 1820	5.9	3.8	310	400

Source: Rozman 1973: 279, 280, 282, and 102; See also Maddison 2007: 39.

2. Estimates of Urbanisation Ratio in China and Europe, Eighth to Nineteenth Centuries (percentage of population living in cities with more than 10,000 inhabitants)

Periods	China	Europe average	Britain
Eighth	3.0	1.8	n.a.
Ninth	n.a.	3.5	0.4
Tenth	n.a.	4.8	2.4
Eleventh	n.a.	5.4	3.1
Twelfth	3.1	5.6	2.2
Thirteenth	n.a.	6.1	2.2
Fourteenth	n.a.	6.7	2.5
Fifteenth	n.a.	6.9	2.1
Sixteenth	3.8	5.6	n.a.
Seventeenth	4.0	8.3	n.a.
Eighteenth	n.a.	n.a.	n.a.
Nineteenth	3.8	10.0	n.a.

Source: data for China is from Rozman (1973: 279, 280, 282, and 102); data for European average and Britain from eighth to Fifteenth centuries are from Buringh and Van Zanden (2009a: 430); data for European average from sixteenth to nineteenth centuries are from De Vries (1984: Tables 2.2, 3.1, 3.2, 3.5, 3.6 and Appendix 1) and Maddison (2007: 40).

Appendix 4: Books Production in China and Europe

	Annul flows		Total numbers of book production		Population (million)		Book per million inhabitants	
	China	Europe	China	Europe	China	Europe	China	Europe
1501-1550	57	1,580	2,850	79,017	150	71	19	1113
1651-1700	471	6,620	23,550	331,035	100	100	236	3310
1751-1800	942	12,576	47,100	628,801	268	170	176	3699

Notes:

Three periods are chosen as an illustration.

It is assumed that the annual flow of book production doubles per 50 years under the Qing.

Total numbers of books production in Europe are based on (Buringh and Van Zanden 2009a: table 2, 417)

Rough estimates of the population of China and Europe are based on (Chao 1986: table 2.3, 41; Maddison 2007: table 1.2., 24).

Even if we double the total number of book production in China in order to include books lost, depreciated, and taken abroad, for example, for the period 1651-1700, the total number comes to 47,100 and per capita number comes to 472. The numbers are still much smaller than European data.

Appendix 5: Monthly Wages in the Late Ming (the Wanli Reign Period, 1572-1620)

Professions	Wages (silver taels)
Postal officer 信差	7.5
Navigator/Sailor 海员	1.6
Theatrical player 戏剧演员	1.5-15
Hired labourer (Lower Yangtze Delta) 雇工(江南地区)	1.5
Construction worker (Beijing) 建筑工人(北京)	1.5
Boatmen 船工	1.2-1.3
Silk craftsmen 丝绸匠	1.2
Porcelain craftsmen 瓷器匠	1.05
Hired labourer (the Yellow River Region) 雇工(黄河流域)	0.9
Hired courier/transporter (Henan) 轿夫(河南)	0.6
Woodblock carver 刊字匠	0.9-1.5
Clerk	1.2-7.5

Source: Chow (2004: table 1.4; 2010: 14-15).

Appendix 6: Official Annual Salaries of the Ming and Qing Officials

Rank	Annual Salaries of Ming officials (shi) / (tael)	Teachers of the Ming Directorate	Annual Salaries of Qing officials (tael)
1 st rank principal class	1044/418		180
1 st rank secondary class	888/355		180
2 nd rank principal class	732/293		155
2 nd rank secondary class	576/230		155
3 rd rank principal class	420/168		130
3 rd rank secondary class	312/125		130
4 th rank principal class	288/115		105
4 th rank secondary class	252/100	Director (<i>jiji</i>)	105
5 th rank principal class	192/77		80
5 th rank secondary class	168/67		80
6 th rank principal class	120/48	Vice-director (<i>siye</i>)	60
6 th rank secondary class	96/38		60
7 th rank principal class	90/36		45
7 th rank secondary class	84/34		45
8 th rank principal class	78/31		40
8 th rank secondary class	72/29	Professor	40
9 th rank principal class	66/26		33
9 th rank secondary class	60/24		31

Source: Wu (1999: 82); Ming Huidian, Vol. 29; Nan Yongzhi, Vol. 1; Zelin (1984: 37, table 2.7); Huang Miantang (1985: 348).

Notes:

One's official salary depended solely on the rank of one's post.

Data on the official annual salaries of Ming officials is based on Wu (1999: 82). Data on the official annual salaries of Qing officials is based on Zelin (1984: table 2.7)

The conversion of Ming official salary from *shi* to *tael* is based on Huang Miantang (1985: 348) that 1 *tael* of silver equalled 2-4 *shi* of rice in the year 1397 (shanxi province), a year close to 1392. My estimate is based on 1 *tael* = 4 *shi*.

Appendix 7: Prices of Books in relation to Wages and Consumption Patterns
Basket of Goods: Beijing

	Quantity per person per year	Price in grams of silver per unit / taels	Spending share in %
Beans/peas	15kg	1.053	3.7
Eggs	52	0.047	0.6
Meat (port and mutton)	20 kg	2.025	9.6
Soy beans	36 kg	0.833	7.1
rice	5 kg	1.418	1.7
wheat	38 kg	1.374	12.3
millet	60 kg	1.029	14.6
corn	34 kg	0.665	5.3
Edible oil	1 l	3.983	0.9
Spirit (18°) (rice wine or other grain wine)	41 l	1.971	19.1
soap	2.6 kg	1.644	1.0
Linen	5 m	6. 109	7.2
candles	2.6 kg	3.286	2.0
Lamp oil	2.6 l	3.286	2.0
Fuel (coal ball)	3.0 M BTU	11.133	7.9
Rent		20. 292	4.8
Total		422.7/11.42	100.0

Source: Allen et al. (2005: table 4)

Note:

Based on price data in Beijing in 1745-54

1 tael = 37 grams of silver

Prices of Books in relation to the basket of goods and wages

	Wages in average (per year/ per day) in taels	Surplus (per year) in taels (wages- total prices for the basket of goods)	Spending share of books below 1 tael in surpluses in %	The numbers of working days to buy books worth 1 tael
Officials	500/2	488.58	0.2	0.5
School teachers	40/0.16	28.28	3.5	6.3
craftsmen	16/0.064	4.58	22	15.6

Source: Wage data are from Chow (2004: 48-50; table 1.4; 2010: 14-15).
Assume one year's work consisted of 250 days.

Appendix 8: Categories and Numbers of Manuscripts and Printed books Deposited in the Siku Quanshu 四库全书 (The Four-Treasury Library)

Categories	Numbers	Categories	Numbers titles/ percent	Categories	Numbers	Categories	Numbers
1. Classics 经部	9,906 15.5%	2. History 史部	14,523 22.74%	3. Philosophy 子部	17,044 26.7%	4. Belles lettres 集部	22,380 35.05%
易 Book of Changes	1,514 2.3%	正史 Standard Histories		儒家 Confucian writers		楚辞 Elegies of Chu	127 0.20%
书 Book of Documents	600 0.94%	编年 Annals		兵家 Military experts		别集 Individual authors	15,986 25.04%
诗 Book of Poetry	742 1.16%	纪事本末 Topically arranged histories		法家 Legalists		总集 Literary anthologies	2,076 3.25%
礼类 Book of Rites		别史 Separate histories		农家 Writers on agriculture	421 0.66%	诗文评 Literary criticism	916 1.43%
春秋 Spring & Autumn Annals	1,036 1.62%	杂史 Miscellaneous histories		医家 Writers on medicine	2,255 3.53%	词曲 Ci Poetry & dramatic songs	3,275 35.05%
孝经 Classic of Filial Piety		诏令奏议 Edicts and memorials		天文算法 Writers on astronomy and mathematics	657 1.03%		
五经总义 Works on the Classics		传记 Biographical works	2,913 4.56%	术数 Divination			
四书 Four Books		史钞 Historical excerpts		艺术 Arts, painting, calligraphy, etc.			
乐 Music		载记 Records of States not recognised as legitimate		谱录 Treatises on miscellaneous subjects (coins, cooking, etc.)			
小学 Philology	1,857 2.9%	时令 Works on chronology		杂家 Miscellaneous writers	3,041 4.76%		
训诂 Comment on literary works		地理 Geography	2,865 4.48%	类书 Encyclopaedias	452 0.71%		
子书 Characters and Writing		职官 Works on evolution of government offices		小说 Novels and incidental writing	2,136 3.35%		
韵 Phonology		政书 Institutional histories		释家 Buddhists			
		目录 Books and epigraphy catalogues	1,352 2.12%	道家 Daoists			
		史评 Historiography					

Sources:
Wang Shuwei (1982: 197-198)
Notes: The total numbers of manuscripts and books is 63,853. This is just a rough calculation, and the percentages are more important. For example, there are 7,600 medical works extant. If we take 3.53 percent, then the total number of medical works should be more than 210,000. See Wang (1982: 198).
Categories related to useful knowledge are highlighted.
Some numbers and percentages are not available.

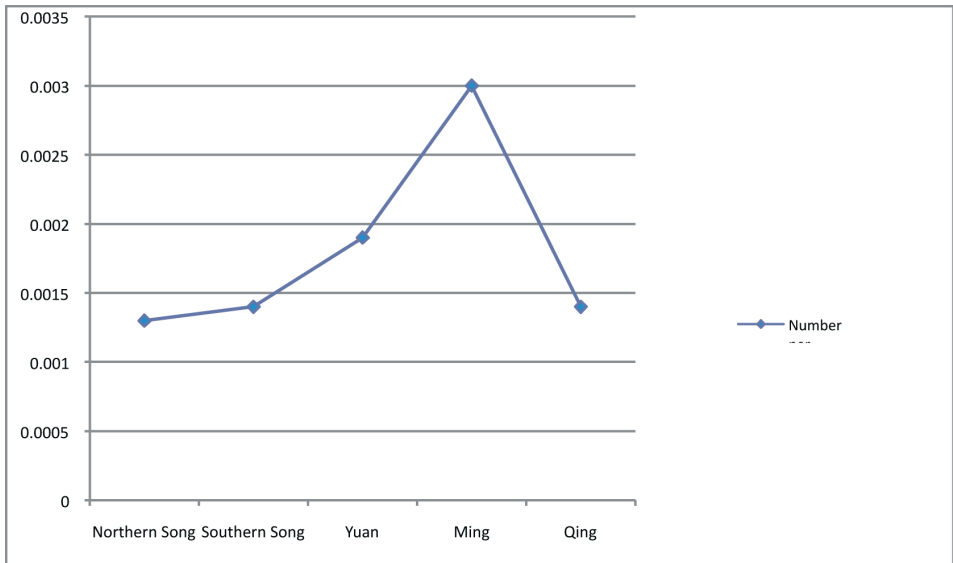
Appendix 9: Jian Yang Publications, Song to Ming

Category (according to the <i>siku</i> classification)	Song %	Yuan%	Ming%
1. Classics 经部	24.5	34.5	13.2
2. History 史部	21.9	13.2	13.4
时令 Works on chronology	0.0	0.0	0.0
地理 Geography ¹⁵³	1.6	1.4	0.8
3. Philosophy 子部	24.0	27.3	45.7
兵家 Military experts	0.0	0.0	0.9
农家 Writers on agriculture	0.5	0.0	0.0
医家 Writers on medicine	4.7	8.6	14.7
天文算法 Writers on astronomy and mathematics	0.0	0.0	0.8
谱录 Treatises on miscellaneous subjects (coins, cooking, etc.)	0.5	0.0	0.1
类书 Encyclopaedias	4.7	12.7	13.9
4. Belles lettres 集部	29.7	25.0	27.7

Source: Chia (2003: 290-291).

¹⁵³ Subcategories including Comprehensive gazetteers 总志, cities and towns 都会, rivers 河渠, famous places, ruins, views 名胜古迹, Travels 游记

Appendix 10: Production of Scientific and Technical Books per Author (based on the highly literate)



Note: The high output of the Yuan may be overestimated because of the dramatic decline of the total population at that time.

Appendix 11: The Publication of Manuscripts and Printed Books Dealing with Scientific and Technical Knowledge in China, 581-1840 (as Classified by Needham)

Dynasty	Sui	Tang	Wudai	Northern Song	Southern Song (including Jin 1115-1234)	Yuan	Ming	Qing	Total number of books
	581-618	618-907	907-960	960-1127	1127-1279	1279-1368	1368-1644	1644-1911	
Duration (years)	37	289	53	167	152	89	276	267	
Mathematics	1	2	0	1	8	9	7	14	43
Astronomy	1	9	0	0	1	3	16	21	52
Geography	5	12	2	8	26	13	41	46	154
Agriculture	0	3	0	5	8	8	10	15	49
Disaster relief	0	0	0	2	2	0	5	2	11
Medicine and nourishing life	5	34	2	35	20	20	62	52	231
Food	1	9	2	10	8	2	24	6	65
Biology	1	11	0	20	22	4	50	32	143
Nautics and ship building	0	0	0	0	1	5	8	2	16
Civil engineering and water control	1	3	1	7	3	4	6	14	41
Military technology	0	4	0	6	10	3	48	7	78
Architecture	0	1	0	5	0	2	9	4	21
Textile	0	3	0	1	3	3	4	21	36
ceramics	0	0	0	0	2	0	1	9	12
Paper and printing	0	0	0	3	0	4	6	6	19
Metallurgy and mining	0	3	0	1	0	1	1	1	7
Crafts	0	0	0	1	6	0	3	3	13
Commerce and industry	0	0	0	0	1	1	1	5	8
Chronology	0	3	0	0	1	0	3	0	7
General studies of the natural world	0	1	1	7	0	2	13	12	37
Cosmography	1	2	1	0	1	0	2	1	8
Mechanical engineering				1		1	1	5	8
Number per dynasty	16	101	9	118	123	87	330	282	1080
Number per year	0.43	0.35	0.17	0.70	0.81	0.97	1.19	1.04	
population (millions) (in the median years)	46.0 (year 600)	52.9 (year 763)	32.0 (year 934)	121.0 (year 1044)	120.0 (year 1203)	59.8 (year 1324)	150.0 (year 1506)	268.2 (year 1778)	
Rates of population increase					-1%	-50%	1.5	78.8%	
Potential number of authors (highly literate)				90,399	89,485	44,743	111,857	200,000	
Literacy rate (highly literate)				7.5/10000	7.5/10000	7.5/10000	7.5/10000	7.5/10000	
authors with the jinshi degrees				9,630	18,694	1,136	24,861	26,747	
Index per author (highly literate)				13	14	19	30	14	

Sources: Needham's *Science and Civilisation in China* series

Sources for population: Zhao Gang (Chao Kang) 1986, table 2.3, p. 71; Kent Deng 1999, Appendix I, pp. 360-362.

The number of *jinshi* (metropolitan degree awarded, equivalent to PhDs): Chaffee (1995: Appendix 3); Wu (1999: 491); Shen 1999; Elman 2000, Tables 1.3, 1.4, and 1.5.

Appendix 12: Scientific Books Produced in Europe

Periods	Number
c.560-c.1400	254
c. 1450-1700	1,546
c. 1640-1859	12,889

Source: Gascoigne (1984)

Working Papers in Technology Governance and Economic Dynamics

The Other Canon Foundation, Norway, and the Technology Governance program at Tallinn University of Technology (TUT), Estonia, have launched a new working papers series, entitled "Working Papers in Technology Governance and Economic Dynamics". In the context denoted by the title series, it will publish original research papers, both practical and theoretical, both narrative and analytical, in the area denoted by such concepts as uneven economic growth, techno-economic paradigms, the history and theory of economic policy, innovation strategies, and the public management of innovation, but also generally in the wider fields of industrial policy, development, technology, institutions, finance, public policy, and economic and financial history and theory.

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9. Antonio Serra, *Breve Trattato / A Short Treatise (1613)* (available only in hardcopy and by request).

10. Joseph L. Love, *The Latin American Contribution to Center-Periphery Perspectives: History and Prospect*
11. Ronald Dore, *Shareholder capitalism comes to Japan*
12. Per Högselius, *Learning to Destroy. Case studies of creative destruction management in the new Europe*
13. Gabriel Yoguel, Analía Erbes, Verónica Robert and José Borello, *Diffusion and appropriation of knowledge in different organizational structures*
14. Erik S. Reinert and Rainer Kattel, *European Eastern Enlargement as Europe's Attempted Economic Suicide?*
15. Carlota Perez, *Great Surges of development and alternative forms of globalization*
16. Erik S. Reinert, Iulie Aslaksen, Inger Marie G. Eira, Svein Mathiesen, Hugo Reinert & Ellen Inga Turi, *Adapting to Climate Change in Reindeer Herding: The Nation-State as Problem and Solution*
17. Lawrence King, Patrick Hamm, *The Governance Grenade: Mass Privatization, State Capacity and Economic Development in Postcommunist and Reforming Communist Societies*
18. Reinert, Erik S., Yves Ekoué Amaïzo and Rainer Kattel, *The Economics of Failed, Failing and Fragile States: Productive Structure as the Missing Link*
19. Carlota Perez, *The New Technologies: An Integrated View*
20. Carlota Perez, *Technological revolutions and techno-economic paradigms*
21. Rainer Kattel, Jan A. Kregel, Erik S. Reinert, *The Relevance of Ragnar Nurkse and Classical Development Economics*
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